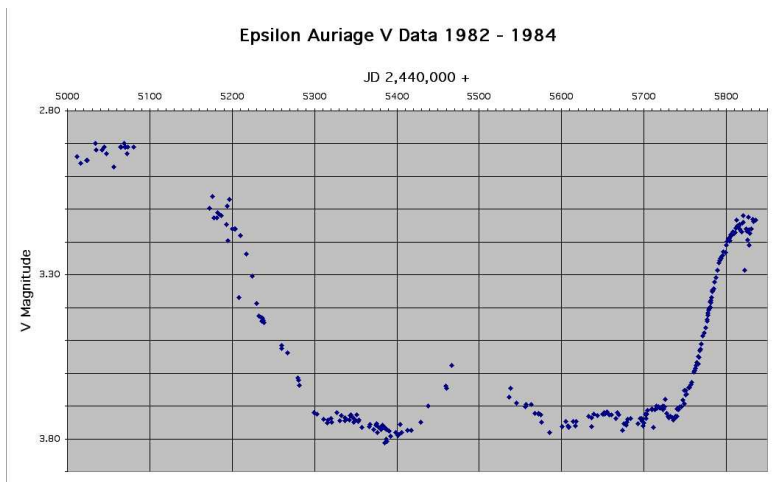


A. Epsilon Aurigae

1. The “Consensus model” for E. Aurigae has the primary star with a radius of 150 times that of the Sun but with a peak luminosity 60,000 times that of the sun. What would its surface temperature be? (10 points)

The light curve of E. Aurigae is shown below for the period 1982 to 1984.



2. What is the ratio (in absolute units) of the maximum luminosity to the minimum luminosity? (5 points)
3. Explain why the shape of this curve is taken as evidence of an eclipsing disk. (5 points)

B. Milky Way Galaxy

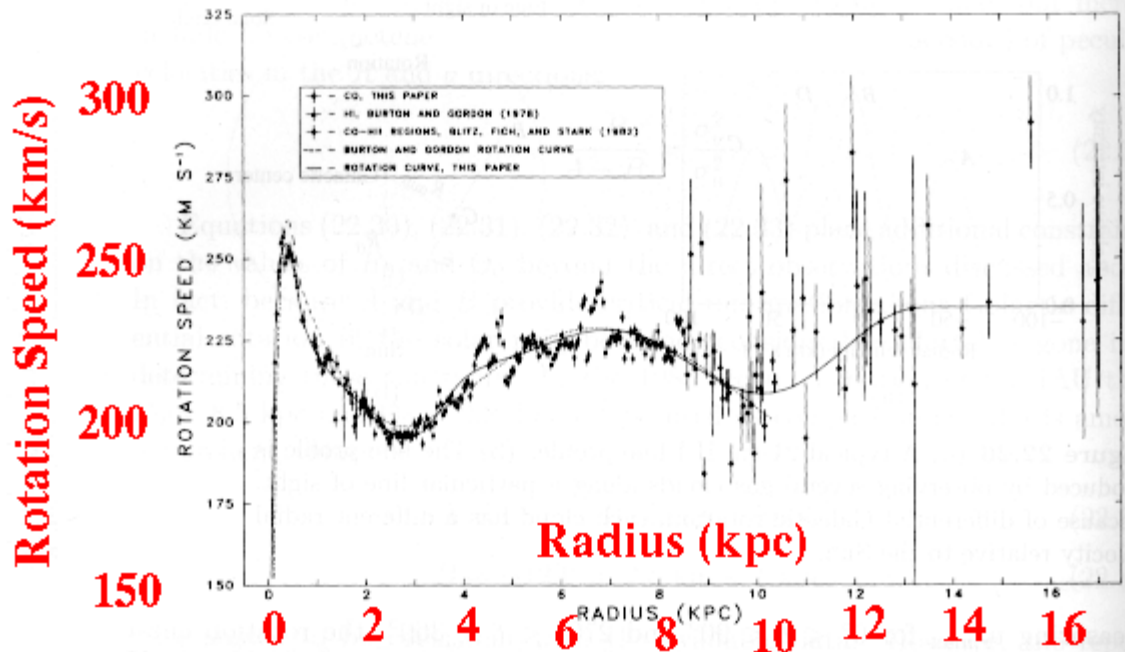


Figure 22.27 The rotation curve of the Milky Way Galaxy. The IAU standard values of $R_0 = 8.5$ kpc and $\Theta_0 = 220 \text{ km s}^{-1}$ have been assumed. (Figure from Clemens, *Ap. J.*, 295, 422, 1985.)

The above is a curve of the rotation speed of the Milky Way Galaxy assuming that we are at a radius R_0 . It is derived largely by looking at the red shift of the 21 cm radio line.

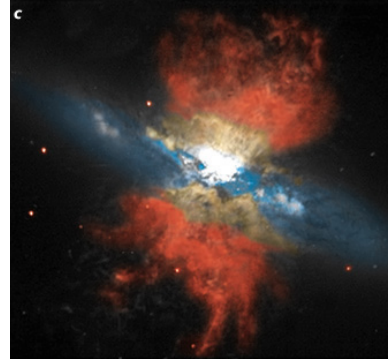
4. What element is associated with this line? (2 points)
5. What band (X-ray, visible, infrared, radio) is this line in, and why is it useful? (4 points)
6. How much would this line shift (in wavelength) at a radius of 2 kpc? (4 points)
7. Why is this curve taken as evidence of dark matter? (10 points)

C. Sgr A*

8. Sagittarius A* is a bright radio and X-ray source in Sagittarius. Why is it interesting? (5 points)
9. This X-ray source brightens and dims over a period of a few months. What constraints does this put on its size? (5 points)
10. The star S2 has been found to orbit SgrA* with a period of 15.24 years and an average radius of 942 AU. What is the mass of SgrA* in solar masses? (10 points)

Peculiar Galaxies

The following are pictures of a galaxy in the optical (top) and Halpha bands (bottom).

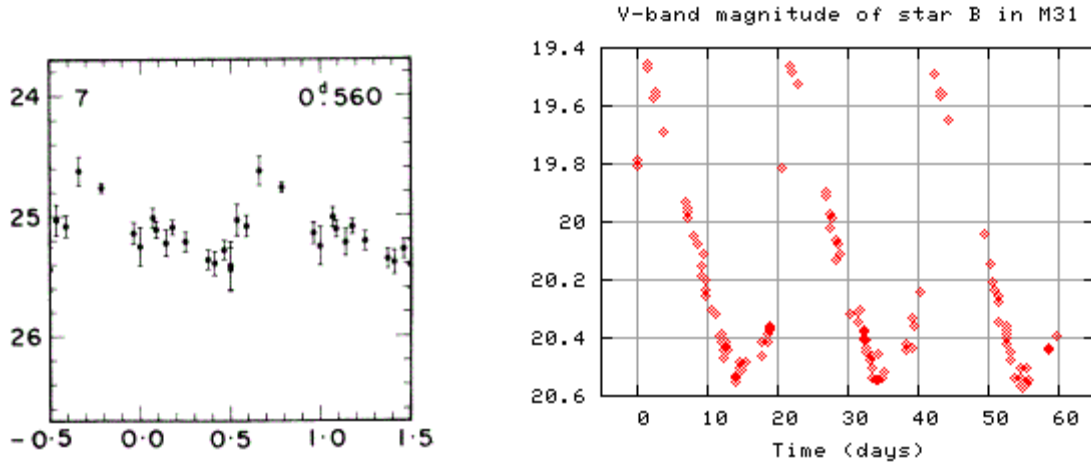


11. What kind of galaxy is this (2 points) and what distinguishes it from other types of galaxies (3 points)?

12. What does the picture in Halpha tell us about this galaxy? (5 points)

E. M31

The plots below show two variable stars in the Galaxy M31. The one on the left is an RR-Lyrae star, the one on the right a Cepheid variable.



13. What is the common name of the galaxy M31? (2 points)
14. Define the distance to M31 in kpc using the RR Lyrae star on the left. (8 points)
15. Define the distance to M31 in kpc using the Cepheid on the right. (8 points)
15. Place the Cepheids and RR Lyrae stars on the H-R diagram on the next page. (2 points each). Also add the Sun and the main sequence. (2 points each).
16. What causes Cepheids to vary? (4 points)

